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**Patent- og Varemærkestyrelsen**
Erhvervsministeriet

Taastrup, 22 June 2000

Karin Schlichting
Head Clerk

# ENCODER

## FIELD OF THE INVENTION

The present invention relates to encoder-switch assemblies such as electro-mechanical roller-key assemblies that comprise an encoder part and an actuator switch. The encoder part may operate according to magnetic, optical and/or electromechanical principles and may provide one or several electrical output signals indicating the instantaneous change of angular position of a rotating roller or tuning wheel of the encoder part of the encoder-switch assembly.

The present encoder-switch assemblies are particularly well adapted for use in mobile phones or, generally, in any type of electronic equipment that will benefit from the very small outer dimensions and simple construction of the present encoder-switch assemblies.

## BACKGROUND OF THE INVENTION

Electromechanical roller-key assemblies which may be used to generate digital control signals in response to a rotation of a roller or tuning knob and to generate an actuator switch signal in response to a depression of the roller are known from e.g. mobile phones. However, the mechanical constructions of these known devices have certain drawbacks due to a large number of miniature movable and stationary parts, often including a tiny detent spring element. This large number of separate parts requires a quite complex and labour intensive assembly procedure to assure that all parts are carefully aligned with respect to each other.

Accordingly, there is a need for an encoder-switch assembly of simplified construction with fewer parts than prior art assemblies so as to simplify the assembly procedure, reduce the assembly time and, consequently, lower the costs of integrating such encoder-switch assemblies in today's mobile phones and similar compact electronic equipment.

## SUMMARY OF THE INVENTION

It is an object of the invention to provide an electromechanical roller-key assembly of simple and robust construction which assembly may be integrated in electronic equipment and generate digital control signals in response to the instantaneous change in angular position of a user operated roller.

It is also an object of the invention to provide an electromechanical roller-key assembly suitable for being manufactured with very small outer dimensions, since such miniaturisation is a key requirement for applications such as hearing aids, compact mobile phones pagers, medical dispensing devices and similar handheld or body-worn devices, etc.

It is further an object of the invention to provide an electromechanical roller-key assembly comprising fewer and simpler mechanical parts compared to prior art roller-key assemblies, thereby making the present electromechanical roller-key assembly suitable for a simplified and automated factory assembly.

In a first aspect, the invention provides an encoder-switch assembly comprising,

a frame,

a first member supported by the frame and being rotatably mounted in relation to the frame,

a coding member engaging the first member in a manner so as to rotate when the first member rotates,

the frame having a first part and a second part, the first part being adapted to support the first member and being displaceable relative to the second part so as to

render the first member displaceable in relation to the second part from an initial position to a displaced position,

means for returning the first member to the initial position,

means for detecting rotation of the coding member in relation to the frame, and

switching means indicating when the first member is in the displaced position,

characterized in that:

the returning means is made from a plate-shaped resilient material and is constituted by the frame.

Accordingly, a roller-key assembly according to the invention may be provided with a coding member that may operate by different sensing principles, such as electromechanical, optical, inductive, capacitive etc. principles.

The frame may be provided in a plate-shaped resilient material e.g. a metallic material of suitable thickness and the first part and the second part of the frame may be separated by one or more indentations of the frame to provide regions with a higher resiliency than regions of the frame abutting the one or more indentations. By attaching the second part to a housing of an apparatus, the frame functions as torsion bar element when a user depresses the first member to activate the switching means. Accordingly, the frame provides a built-in detent spring functionality.

In a preferred embodiment of the invention, the switching means are adapted to indicate the displaced position of the first member by forming an electrical connection between a protrusion of the first part of the frame and an electrical conductor or pad positioned in a fixed manner relative to the second part of the frame and/or relative to the external housing or casing or frame. This embodiment

has the advantage that it provides a much simpler actuator switch element than prior art membrane switches.

According to a preferred embodiment of the invention, the coding member is integrated with a cylindrically shaped first member, by forming a part of the coding member by arranging between 5 and 25 protrusions along a substantially axially oriented surface path on the end surface of the cylindrically shaped member. A disc-shaped metal plate comprising 5 to 25 holes of dimensions corresponding to dimensions of the protrusions may be fitted onto the end surface of the first member so as to form a circular and plane encoding disc. The protrusions thus provide a number of non-conducting pads on the encoding disc while the metal areas constitutes electrically conducting pads. In this embodiment of the invention, the intermittently arranged conducting and non-conducting pads may be electrically interconnected by a circular area of the metal plate. The pads and the circular area may be contacted by scanning means comprising a first, a second and a third contact member. The circular area thus provides a conducting path without the intermittent pattern of conduction and non-conducting pads and may be used as an electrical contact path for the third contact member during rotation of the disk.

Each of the contact members may be electrically connected to a corresponding externally accessible pin or terminal. The pins associated with the first and second contact members may each be connected, through predetermined a pull-up resistor, to a voltage supply provided by an electronic apparatus into which the electromechanical encoder is to be integrated. The leg part or pin associated with the third contact member may be directly connected to a ground terminal in the apparatus so that by rotating the encoder disk short circuits and open circuits are intermittently generated between the first pin and the third pin and between the second pin and the at least one third pin. Consequently, on each of the first and the second pin a pulse train is generated that comprises a number of pulses per revolution of the encoding disk proportional to the number of conducting pads arranged on the encoding disk.

The rotatably mounted cylindrically shaped first memb r may function as a user operated roller. The roller may comprise corrugated grooves disposed along a substantially axially oriented surface path on the end of the cylindrically shaped member opposite to the end that comprises the encoding disc. The grooves may be in contact with a spring member formed in the frame and provide a biasing force against the corrugated grooves, thereby providing a user operating the roller with tactile feedback to assist him/her in determining the angular rotation of the roller.

In a another embodiment of the invention an encoder-switch assembly is provided comprising,

a frame,

a first member supported by the frame and being rotatably and displaceably mounted in relation to the frame, the first member being rotatable in relation to the frame in a first plane,

the first member being displaceable in relation to the frame between an initial position and a displaced position,

a resilient element for returning the first member from the displaced position to the initial position,

switching means indicating when the first member is in the displaced position,

a coding member engaging the first member in a manner so as to rotate when the first member rotates,

means for detecting rotation of the coding member in relation to the frame,

means for transferring rotational force from the first member to the coding member,

the coding member being fixedly connected to the frame, and the first member being rotatably mounted in relation to the coding member.

The transferring means of the rotational force may comprise a substantially rigid shaft which at a first end is connected to the first member in a manner so that the shaft is rotatable in relation the first member in a plane not being parallel to the first plane and at a second end is connected to the coding member in a manner so that the shaft is rotatable in relation the first member in a plane not being parallel to the first plane.

## BRIEF DESCRIPTION OF THE DRAWINGS

Hereunder, preferred embodiments of electromechanical roller-key assemblies according to the invention are described with reference to the drawings, wherein

Fig. 1 shows three different views, a cross-sectional view and two perspective views, of a first embodiment of an electromechanical roller-key assembly according to the present invention,

Fig. 2 is a cross-sectional view of the assembled electromechanical roller-key assembly illustrated in Fig. 1,

Fig. 3 shows two different views, a cross-sectional view and a perspective view, of a second embodiment of an electromechanical roller-key assembly according to the present invention,

Fig. 4 shows four different perspective views of various elements of a third embodiment of an electromechanical roller-key assembly according to the present invention,

Fig. 5 illustrates a metal frame which forms part of the electromechanical roller-key assembly shown in Fig. 4,

Fig. 6 illustrates an exemplary electromechanical encoder which may provide a suitable disc-shaped coding member adapted for use in the electromechanical roller-key assembly shown in Fig. 4.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 shows various views of an electromechanical roller-key assembly according to a first preferred embodiment of the invention. A plastic moulded cylindrical roller is rotatably mounted in a supporting frame. A detent spring is also mounted on the frame and further attached to or abutting the roller in a manner that allows the roller to return to a rest position after it has been vertically depressed in order to activate a membrane switch which may be positioned below the roller on e.g. a printed circuit board (PCB). The rotation of the roller is transferred to a coding member housed in an encoding module by means of a shaft that provides a relatively rigid connection between the roller and the coding member. Fig. 2 illustrates that predetermined clearance is provided at both ends of the shaft, this clearance provides a mechanism that allows the roller to move vertically (in the direction illustrated by arrow 200) without transferring such vertical movement to the encoding module. The encoding module and the frame may accordingly be fixed to the same printed circuit board as the membrane switch by directly soldering the three leg parts of contact members to corresponding solder pads located on the PCB. Consequently, the present embodiment of the invention does not require flexible connection wires or equivalent flexible connecting means in order to transfer electrical signals from the encoding module to detecting circuitry arranged on the PCB. Preferably, the electromechanical roller-key assembly also comprised an O-ring positioned between the frame and the coding member to seal the encoding module and the coding member from moist and other external contamination.

Fig. 4 shows various elements of an electromechanical roller-key assembly according to another preferred embodiment of the invention. An assembled roller

key assembly 450 is also illustrated in a perspective view. A plastic moulded cylindrical roller 410 is rotatably mounted in a metal frame 420. A first end surface of the roller 410 contains a corrugated groove adapted to contact a detention spring protrusion 425 formed in the metal frame 420 when the roller 410 is mounted in the frame 420. A disc-shaped coding member is formed in a second end of the roller 410 by pressing and aligning a number of holes in a metal disc 400 onto a number of corresponding protrusions which are moulded in the second end of the roller. The holes and protrusions may be arranged along a substantially axially oriented surface path relative to an axis of rotation of the coding member. Accordingly, the second end of the member may constitute an encoding disk comprising a number of intermittently arranged conducting and non-conducting pads. By providing the protrusions on the roller 410 with substantially the same height as the thickness of the metal disc 400 a plane surface of the coding member may be provided and contacted by scanning means comprising a first, a second and a third contact member, 435, 436, and 440, respectively. The third contact member 436 is formed in the metal frame 420 and thereby electrically connected to it. Thereby, during rotation of the coding member, electrical contact is intermittently established from the first and the second contact member, 435 and 440, respectively, to the at least one third contact member and two pulse trains of differing phase with respect to each other may be provided at the leg parts of the first and second contact members by connecting each of the leg parts of the first and second contact member to an appropriate supply voltage through pull-up resistors. The metal frame 420 is preferably manufactured in a single piece of plate-shaped material as illustrated in Fig. 5. The metal frame 420 is divided into a first part (503 and 504) which is adapted to support the roller 410 at its end surfaces, and a second part 422 which can be rigidly mounted in a casing or housing of an apparatus (not shown) in which the roller key assembly 450 is to be integrated.

By providing two indentations in the metal frame 420, items 500 and 501 of Fig. 5, the first part is made displaceable in relation to the second part 422. Accordingly, when the second part 422 is rigidly mounted in an apparatus housing and a force is applied to the roller 410 the first part (and the roller 410 holding the coding

member) is displaced from a rest or initial position to an activated position and a torsion spring force is created in the first part so as to return the roller to its rest position when the applied force is removed. Accordingly, the frame itself functions as a detent spring so that there is no need for a separate spring element. Another advantage of the metal frame is it may further act as a de-coupling element of electrostatic charge that may build up on the roller.

The displacement of the first part may bring an actuator contact 430 which is integrated with the first part of the metal frame 420 in electrical contact with a electrically conducting pad arranged on e.g. a printed circuit board and positioned below the actuator contact 430. Thereby an actuator switch element is integrated together with the electromechanical roller-key assembly 450 and this switch element may provide two level switching signal to a detection circuit in response to a user depressing and releasing the roller 410.

The first and second contact members 435 and 440 are preferably provided as an integrated part of the metal frame 420. By utilising an insert moulding process, two plastic bearing elements 441 and 442 are attached to the first part of the metal frame. The first and second contact members 435 and 440 must be mechanically and electrically separated from each other and from the metal frame 420 before or after the insert moulding process so as to provide 3 electrically separate contact members. The plastic bearing elements are utilised to mount the roller 410 in a precise predetermined and rotatable manner relative to the metal frame 420 and to the first, second and third contact members.

A mechanical connection in the form of a cross-bar or shaft may be added between elements 503, 504 (Fig. 5 ) of the metal frame after it has been bend into a U-shape at the marked regions, as illustrated in Fig. 4, thereby providing a frame of improved mechanical stability.

Fig. 6 is a perspective view of a number of separate elements comprised in an exemplary electromechanical encoder unit. A member 30, constituting a first part of

the encoder disk 1, is provided as a single part moulded in a thermoplastic material with or without reinforcement. The member 30 also defines the positions of the non-conducting pads 2 of the encoder disk 1 by means of twelve wedge-shaped protrusions arranged along a substantially axially oriented path relative to an axis of rotation of the disk. A conducting member 20 which is provided as a circular disk with a centrally located circular aperture 31 constitutes a second part of the encoder disk 1. This member 20 comprises a number of wedge-shaped apertures 32 adapted to fit into the corresponding protrusions 2 provided in the member 30. The member 20 may be provided by different manufacturing methods such as through insert moulding or through depositing a layer of conductive material in the preferred pattern on the thermo-plastic member 30. The pads are thus arranged as a circular measuring scale between two radial boundaries positioned relatively near to the circumference of the encoding disk, and the circular area may be positioned radially inside or outside of the circular measuring scale. Thereby, a circular area or path is left without the intermittent pattern of pads so that this path may be used as a contact path for the third contact member during rotation of the disk. The circular aperture 31 is adapted to receive the end part of a shaft 40 that may be operated by a user. Front and rear housing parts 50 and 60, respectively are provided with contact means 51 which provides snap-fit assembly of the housing parts. Furthermore, an inner surface in the rear part 60 is provided with a projection abutting against each of the at least three contact members to provide a contact or bias force between the contact members and the encoding disk.

A first electrical conductive terminal or leg part 52 comprises the second contact member (not shown) and a corresponding externally accessible pin 15. Terminal 52, 53 and 54 are, preferably, provided in a solderable material and/or corrosion-resistant material such as copper, silver, gold-coated steel, palladium-nickel, gold-platinum, gold-nickel alloys, etc. Correspondingly, each of terminals 53 and 54 are also provided with a corresponding contact member (not shown) and an externally accessible terminal.

CLAIMS

1. An encoder-switch assembly comprising,

a frame,

a first member supported by the frame and being rotatably mounted in relation to the frame,

a coding member engaging the first member in a manner so as to rotate when the first member rotates,

the frame having a first part and a second part, the first part being adapted to support the first member and being displaceable relative to the second part so as to render the first member displaceable in relation to the second part from an initial position to a displaced position,

means for returning the first member to the initial position,

means for detecting rotation of the coding member in relation to the frame, and

switching means indicating when the first member is in the displaced position,

characterized in that:

the returning means is made from a plate-shaped resilient material and is constituted by the frame.

2. An encoder-switch assembly according to claim 1, wherein the frame is a plate-shaped resilient material.

3. An encoder-switch assembly according to claim 2, wherein the first part and the second part of the frame are separated by one or more indentations of the frame to provide regions with a higher resiliency than regions of the frame abutting the one or more indentations.

4. An encoder-switch assembly according to claim 2 or 3, wherein the second part of the frame further comprises engaging means adapted to being substantially rigidly attached to corresponding engaging means of an external housing or casing or frame.

5. An encoder-switch according to any of the preceding claims, wherein the switching means are adapted to indicate an electrical connection between a protrusion of the first part of the frame and an electrical conductor or pad positioned in a fixed manner relative to the second part of the frame and/or relative to the external housing or casing or frame.

6. An encoder-switch assembly according to any of the preceding claims, wherein a part of the coding member is integrated with the first member.

7. An encoder-switch assembly according to any of the preceding claims, wherein the first member comprises a substantially cylindrically shaped member having the part of the coding member formed on an end surface.

8. An encoder-switch assembly according to claim 7, wherein the part of the coding member is provided by arranging between 5 and 25 protrusions along a substantially axially oriented surface path on the end surface of the cylindrically shaped member.

9. An encoder-switch assembly according to claim 8, wherein the coding member is formed by mounting a metal disc on the end surface part of the cylindrically shaped member, the metal disc comprising 5 to 25 holes of dimensions corresponding to dimensions of the protrusions.

10. An encoder-switch assembly according to claim 9, wherein the assembly comprises at least three contact members being adapted to scan the end surface part of the cylindrically shaped member, each contact member having a corresponding leg part.

11. An encoder-switch assembly according to claim 10, wherein the at least three contact members and the corresponding leg parts are formed in the frame.

12. An encoder-switch assembly according to any of claims 1 -5, wherein the coding member comprises a disc-shaped member comprising a number of intermittently positioned holes along axially oriented path of the disc-shaped member, and wherein the detecting means comprise a light emitter positioned so as to transmit light through the holes to a detector positioned so as to receive light pulses when the disc-shaped member is rotated.

13. An encoder-switch assembly comprising,

a frame,

a first member supported by the frame and being rotatably and displaceably mounted in relation to the frame, the first member being rotatable in relation to the frame in a first plane,

the first member being displaceable in relation to the frame between an initial position and a displaced position,

a resilient element for returning the first member from the displaced position to the initial position,

switching means indicating when the first member is in the displaced position,

a coding member engaging the first member in a manner so as to rotate when the first member rotates,

means for detecting rotation of the coding member in relation to the frame,

means for transferring rotational force from the first member to the coding member,

the coding member being fixedly connected to the frame, and the first member being rotatably mounted in relation to the coding member.

14. An encoder-switch assembly according to claim 13, wherein the transferring means of the rotational force comprises a substantially rigid shaft which at a first end is connected to the first member in a manner so that the shaft is rotatable in relation the first member in a plane not being parallel to the first plane and at a second end is connected to the coding member in a manner so that the shaft is rotatable in relation the first member in a plane not being parallel to the first plane.

15. An encoder-switch assembly according to claim 14, wherein a part of the shaft at the first end thereof has a predetermined geometrical shape and wherein the first member comprises a part having an at corresponding, inverse geometrical shape being adapted to receive and engage the part of the shaft in a manner so that rotational force is transferred from the first element to the shaft, when the first element is rotated in the first plane.

16. An encoder-switch assembly according to claim 15, where the corresponding, inverse geometrical shape of the part of the first element has a shape having internal dimensions larger than corresponding outer dimensions of the part of the shaft.

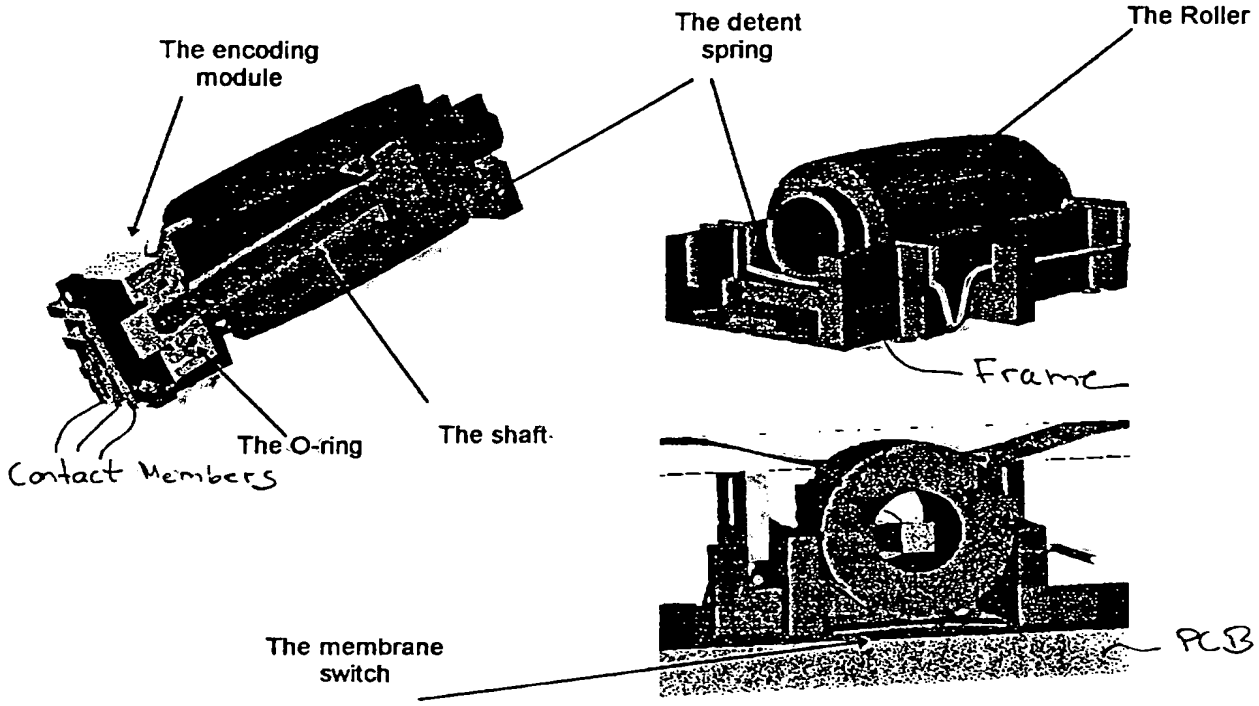


Fig. 1

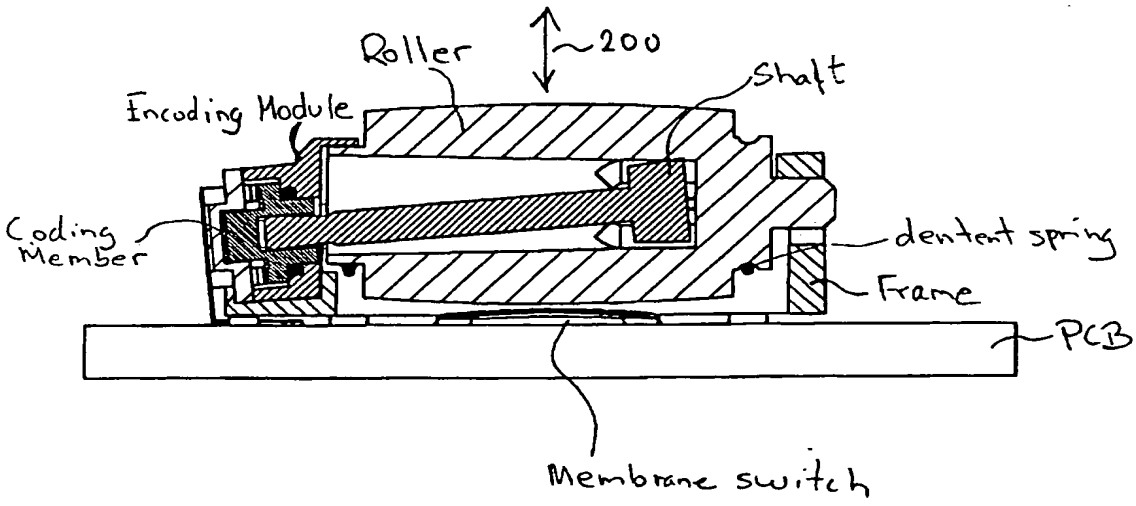


Fig. 2

**Solution 2**

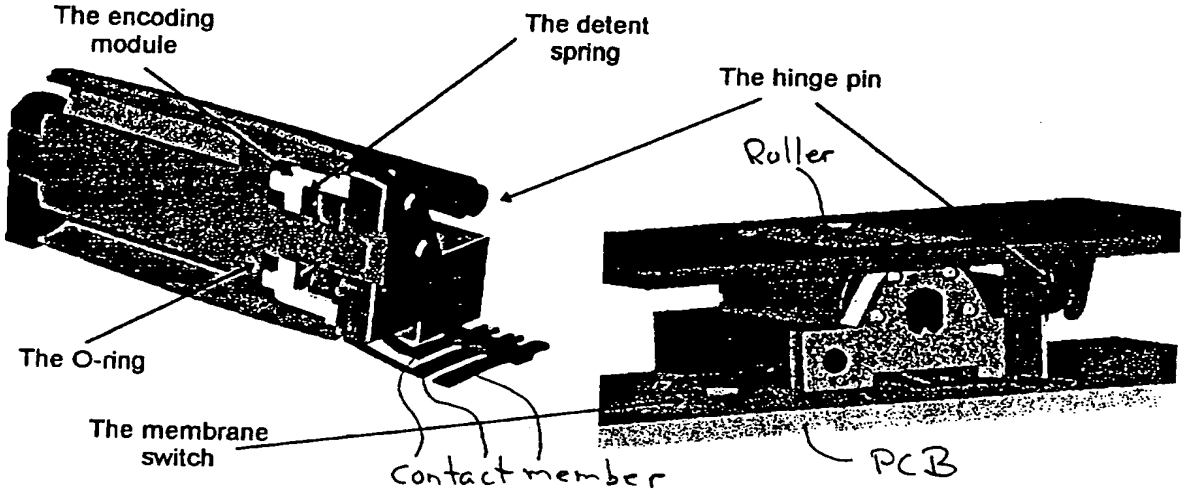


Fig. 3

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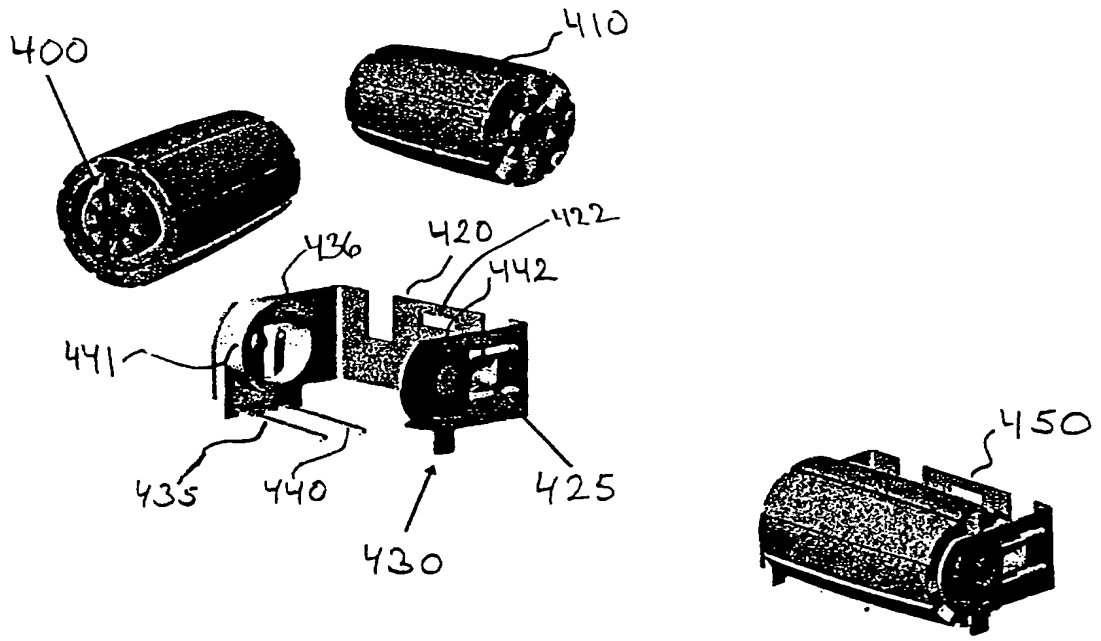


Fig. 4

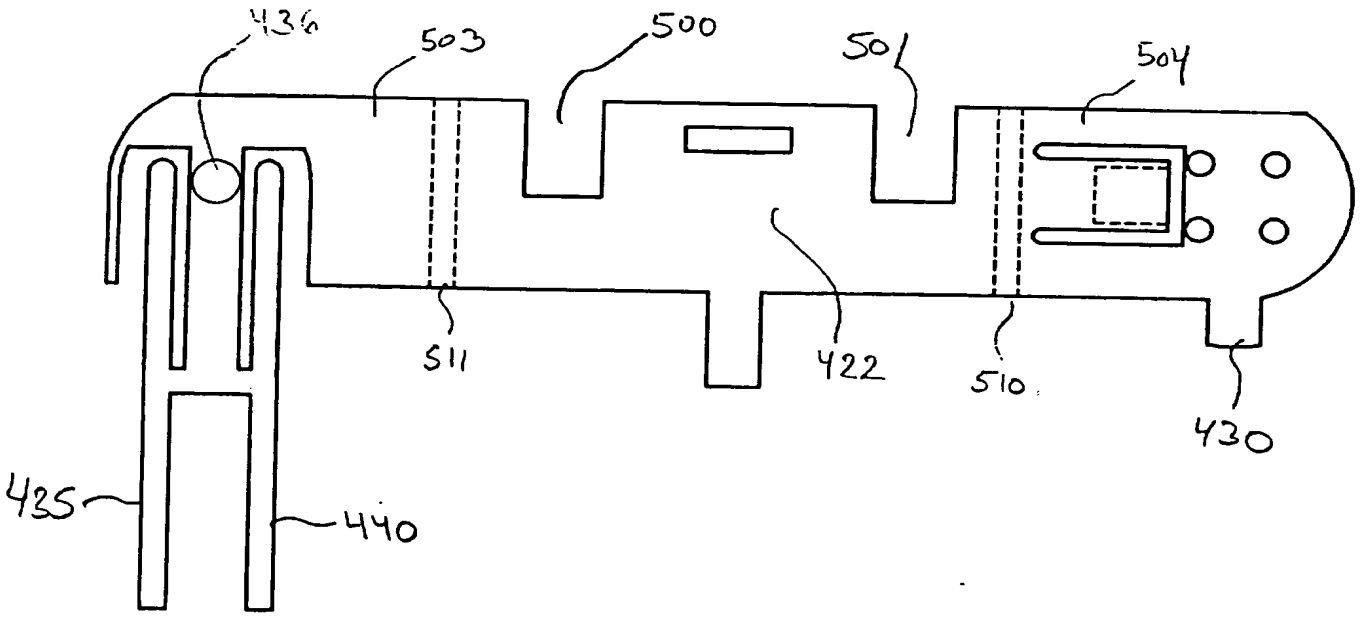


Fig. 5

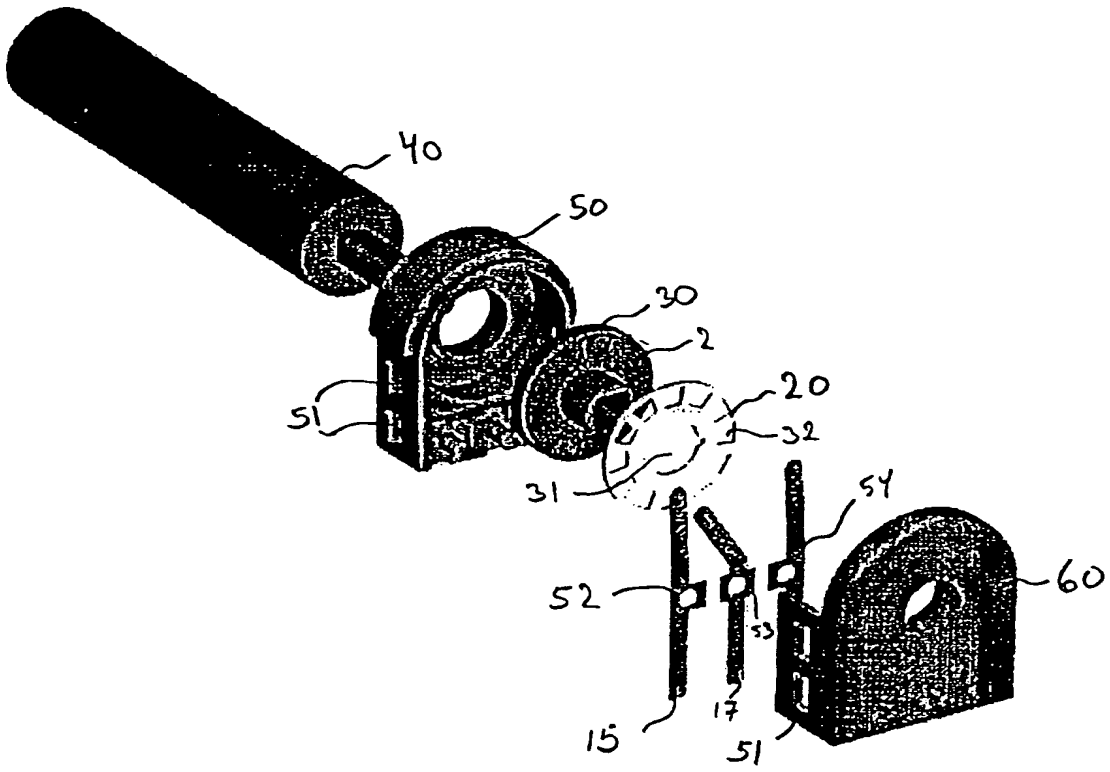


Fig. 6